K 5: Laser-Beam Matter Interaction – Light and Radiation Sources II

Time: Tuesday 11:00–12:15 Location: HS XI ITW

Invited Talk K 5.1 Tue 11:00 HS XI ITW

Fundamental investigations on the ablation of thin metallic films upon irradiation with ultrafast laser radiation — •Alexander Horn, Theo Pflug, Andy Engel, and Markus Olbrich — Laserinstitut Hochschule Mittweida

Understanding the fundamental processes of ablation induced by the irradiation with ultrafast laser radiation represents the key parameter in explaining the results of laser-material processing. By combining our complementary ultrafast metrology such as pump-probe imaging reflectometry, interferometry, and spectroscopy the dynamic of ablation can be determined by measuring the change of the optical properties from the femtosecond up to the microsecond range. Additionally, a modeling of the interaction of the laser radiation with the material must be performed to assign the changes of the optical properties to physical processes such as excitation of the electron system, generation of shockwaves, spallation, and phase explosion or the expansion of the induced ablation plume. The modeling includes the two-temperature model in combination with the hydrodynamics (TTM-HD) as well as the beam propagation of the probe radiation.

K 5.2 Tue 11:30 HS XI ITW

Investigations on the ablation and the irreversible material changes of single-crystalline silicon irradiated with ultrashort pulsed laser radiation — •Andy Engel, Markus Olbrich, Theo Pflug, and Alexander Horn — Laserinstitut Hochschule Mittweida, Hochschule Mittweida, Technikumplatz 17, 09648 Mittweida, Germany

In this study the irradiation of single-crystalline, <111> -oriented silicon is investigated by varying the fluence of the applied ultrashort pulsed laser radiation (pulse duration 40 fs, wavelength 800 nm) and the number of single pulses per spot. The resulting irreversible material changes due to the laser radiation-matter interaction are presented and discussed. These material changes were observed by measuring the spatial- and spectral-resolved refractive index using ex-situ ellipsometry and SEM analyses. Comparative analyses of the topography of the irradiated surfaces were performed using confocal laser scanning microscopy and atomic force microscopy. Additional information about the depth of the thermally induced material phase changes have been obtained by downstream wet chemical etching. The ex-situ analyses were supported by ultrafast metrology, pump-probe imaging reflectometry and interferometry as well as optical modeling and simulations of the laser-matter interaction. This complementary approach enables a more accurate description of the physical processes induced by ultrashort pulsed laser irradiation, starting from changes in crystallinity up to ablation.

K 5.3 Tue 11:45 HS XI ITW

GASFIR: How to retrieve the dynamics of strong-field ionization from ionization probabilities — •Manoram Agarwal[1] and Vladislav Yakovlev[2] — [1]Max Planck Institute of Quantum Optics — [2]Ludwig-Maximilians-Universität München

We introduce the General Approximator for Strong-Field Ionization Rates (GASFIR), a model that reconstructs nonadiabatic, sub-optical-cycle ionization dynamics for an arbitrary optical pulse impinging on an atom or solid. This reconstruction uses only a few ionization probabilities for precisely known electric fields as input. These probabilities can be obtained from numerical calculations or experimental measurements, highlighting the non-trivial fact that ionization probabilities contain sufficient information to reconstruct the underlying dynamics. Due to its nonadiabatic nature, GASFIR is applicable to multiphoton and tunneling ionization, as well as the intermediate regime.

K 5.4 Tue 12:00 HS XI ITW

Ultra-Narrowband Coherent THz Source for Quantum Control and Advanced Spectroscopy Applications — Peng Han[1], Steven. L. Johnson[1,2], and •Biaolong Liu[1] — [1]Pump laser group, laboratory of nonlinear optics, center of photon science, Paul Scherrer Institute — [2]Institute of quantum electronics, Department of physics, ETH Zürich

The development of compact terahertz (THz) sources capable of generating high field strengths (>100 kV/cm) with narrow bandwidth (<10%) has become crucial for manipulating functional properties in quantum materials by selectively activating specific low-energy excitations. In fact, many collective modes have linewidths below 100 GHz. Moreover, the spacing between first neighboring modes can be in the same order of the linewidths. Thus, there is a high demand on THz pulses with even narrower bandwidth (<3%). However, this remains challenging, especially within the 3-15 THz range, commonly referred to as the "THz gap". Here, we present a tabletop, ultra-narrowband (<3% bandwidth) THz source, capable of delivering sub-microjoule, carrier-envelope-phase stable, transform-limited transients tunable between 3 and 4 THz, utilizing a chirped-pulse DFG approach. This source will be ideal to create entangling gates in nanostructured semiconductors by optically manipulating the quantum states of Rydberg atoms for quantum information processing. This novel, coherent THz source holds promise not only for quantum device integration but also as a valuable resource for large-scale solid-state research and, potentially, time-resolved studies in chemistry and biology.